CO_2 Separation with Polymeric Membrane

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Recent intensive investigations have warned against the global climate change and global warming triggered by the rise in atmospheric concentration of greenhouse gases, particularly carbon dioxide (CO_2). CO_2 capture and storage are of great important and impatient to mitigate CO_2 emission. A number of investigations have been made to develop effective CO_2 separation methods. As represented by the Selexol, a solvent absorption of CO_2 gained current acceptance, however, a membrane separation would be more promising in terms of both technological and economical perspectives. Polymeric membranes would be the most accessible due to versatile chemical approaches, synthetic feasibility, large-scale production, processability, and cost in comparison to other membranes, such as zeolites.

In this presentation, recent progress of preferential CO_2 separation over H_2 is discussed with a polymeric membrane composed of poly(amidoamine) (PAMAM) dendrimer immobilized in poly(ethylene glycol) (PEG) network upon photopolymerization of PEG dimethacrylate in the presence of PAMAM dendrimer. The polymeric membrane demonstrates excellent CO_2 separation performance over H2 as shown in Fig. 1. The CO_2 separation properties are strongly depended on the dendrimer concentration, generation, PEG length, and humidity. Mechanism of the preferential CO_2 permeation has been investigated. Higher humidified condition facilitates the dendrimer diffusion through the polymeric membrane, resulting in increase in CO_2 sorption via specific interaction between CO_2 and primary amines of PAMAM dendrimer. Inverse gate decoupling ^{13}C NMR experiment suggests that CO_2 turns to be carbamate and bicarbonate ion. Bicarbonate ion would be the major traveling species through the membrane, while carbamate suppresses H_2 permeation by cross-linking of the dendrimers, so called "a CO_2-selective molecular gate" effect.

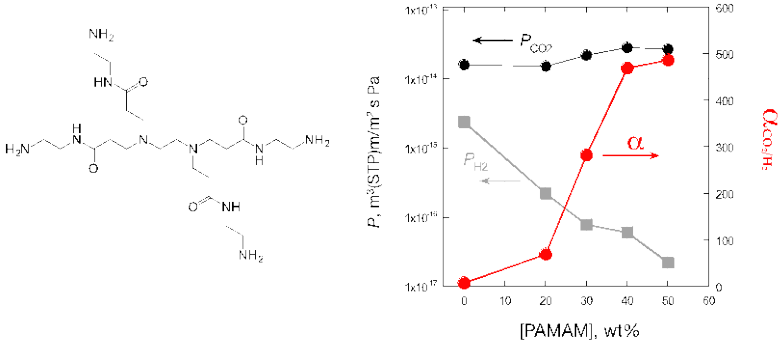

Fig. 1. Chemical structure of PAMAM dendrimer (G: 0th) and CO_2 separation performance of PAMAM dendrimer containing polymeric membrane. Feed and sweep gas: H_2/CO_2 (95/5 by vol.) and He, respectively, relative humidity: 80 % at 298 K